Research Article

Removal of Anionic Surfactants from Industrial And Domestic Waste Water Using a Bio Adsorbent Embelia Ribes in Region Bilaspur Chhattisgarh, India

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Abstract

The aim and purpose of the current work is to investigate the bio adsorption process of an anionic surfactant by a bio adsorbent Embelia Ribes (vaividang). The removal of persistent pollutants anionic surfactants by bio adsorption treatment processes was investigated as an enhancement technique. However, due to adsorptive properties of surfactants it was necessary to examine the amount of surfactant adsorbed on vavidang, during treatment. Various parameters such as agitation time, adsorbent dose, initial concentration of adsorbate and pH were studied on the laboratory scale to establish optimum conditions for the removal of anionic surfactant sodium dodesyl sulphate (SDS) from the effluents of different domestic and industrial waste water. Results showed that vavirang exhibit reasonably good removal for SDS and significantly adsorbed by the adsorbent over the pH range 2.0-4.0. When the initial surfactant concentration was 2gm/L, the adsorption capacity of SDS increased with the rise of agitation time and increased dose of adsorbent to the some extant, after that it started to decrease and acquired steady condition. However the % of SDS removal correlates inversely with the initial surfactant concentration.

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Introduction

Surfactants are widely used throughout the world. The use of surfactants gradually increased day by day. Surfactant products are used in large quantities for industrial application [1] such as food, paints, polymer, plastics, pharmaceuticals, cosmetics, textiles, fibers etc. Anionic surfactants (AS) are popular detergent ingredients, because of their straight forward synthesis and consequently low production costs .The abundance of AS used in to domestic and industrial cleaning agent encourages studies of their fate in domestic wastewater especially where such water is to be re-used for irrigation and other secondary works. AS are mostly used in detergent formulations and are finally directed in their entirety into the sewages. They cause pathological, physiological, and biochemical effects on aquatic animals and aquatic plant species [2-5] because detergent product and its ingredients can be relatively toxic to aquatic life. As a consequence of their widespread use and strong resistance to biodegradation, surfactants may persist in wastewater treatment systems at relatively high concentrations [6, 7]. The amount of surfactants present in

wastewaters of many industries, especially detergent and textile, must be reduced at least to acceptable levels before discharging to the environment. Prior to disposal in the environment an efficient treatment process must be applied. Due to its non bio degradability, waste water is very difficult to treat [8]. The conventional methods for surfactant removal from water involve processes such as chemical and electrochemical oxidation 9, membrane technology 10, chemical precipitation 11, photo-catalytic degradation 12, adsorption [13, 14] and various biological methods [9]. So there are several conventional methods used for the removal of surfactants from wastewater, but they are more sophisticated and not satisfactory enough for the hardly biodegradable pollutants. All these methods have disadvantages such as incomplete ion removal, high energy requirements, and production of toxic sludge or other waste products that require further disposal. The aim of the study is to evaluate the suitability of different types of ultra filtration media for treatment of industrial and domestic waste waters containing anionic surfactants. The bio adsorption process is used especially in the waste water treatment field and an investigation has been made to determine inexpensive and good adsorbents. The objective of this work is to develop a high performance and economical process for the treatments of anionic surfactants present in wastewaters through a bio adsorption process. Vaividang (Embelia ribes) commonly known as False Black Pepper is used as a low-cost abundantly found bio adsorbing material [15]. It is widely distributed throughout India and one of the widely and commonly used ayurvedic herb. It is a coarse-grained, black colored material.

Figure 1 Embelia Ribes (Vaividang)

Figure 2 Dry seeds of vaividang (False black pepper)

Experimental - Materials and method

Reagents

Azure A, Sodium dodesyle sulphate, Hydrochloric acid, Chloroform. The chemical and reagent were used for analysis were of Analytical reagent grade.

Absorbent

Seeds of the vaividang (Embelia ribes) were grind in to domestic mill in the powdered form. Further throughout the paper vaividang will be given the terms as Bioadsorbate V-1/ (B A V-1).

Figure 3 Powdered vaividang

General Surfactant Removal Assay

10-100 ppm solution of sodium dodesyl sulphate was prepared. Different volumes of this solution were put into recipients and controlled quantity of adsorbents dosage was added. A vigorous shaking was applied for 15- 20 minutes using a REMI shaker of 120 rpm until equilibrium was achieved. Then a sample was taken and it was centrifuged. Surfactant removal was determined by visible spectrophotometry.

Surfactant analysis

For measurement of concentration of anionic surfactants SDS, rapid and sensitive Spectrophometric estimation method is developed. Azure A cationic dye is used as ion pairing with AS. An ion pair complex of cationic dye Azure A and anionic surfactant SDS is extracted in chloroform in the presence of hydrochloric acid. The content are shaken for 2 minute and then allowed to settle for 3 min. The Chloroform layer is collected and 2.5 ml of this used directly for the absorbance maximum. The absorbance of the complex in Chloroform layer is measured at maximum wavelength (ʎ max.) at 555 nm.

Batch adsorption experiment method

The surfactant used in this project is anionic sodium dodesyl sulphate.
Temperature: 25^0-30^0C

The Industrial and domestic waste water contaminated with SDS was treated with biomass in a batch experiment. The experiments done without biomass were treated as blanks. To study the effects of pH on the ability of bioadsorbent vaividang to adsorb anionic surfactants SDS was investigated. For this purpose 100 ml of the aqueous solution of 2 mg /L of SDS was adjusted to pH level 2, 3, 4, 5, 6, 7, and 8 using Dilute H_2SO_4 and NaOH. 2 gm. powdered vaividang were added to these solution and they were kept in stirrer for 2 hrs. Then the solution were filtered through whatmanns filter paper no 42, then visible spectrophotometer (Systronics-105) measured the concentration of SDS remaining in the solution. The effect of time was also studied in a time period of 1, 2, 3, 4, 5 and 6 hr. In the similar manner effects of doses of adsorbent (1-100 gm/L) and effects of concentration of adsorbate (1-100 mg/L) were also studied.

Result and Discussion

Adsorption of anionic surfactant
Effect of pH

The obtained results in different pH indicate that adsorption value increase in low pH (Figure 4). So that, up to 90 % of 100 ml anionic surfactant solution containing 2mg/L of SDS was adsorb by 2 gm. of vaividang. While the adsorption value is very low at 6-7 pH in the same condition. As it can be appreciated a fix dose of 2 gm/L of vaividang of BAV-1. The graph between pH and bioadsorbent shows a marginal decrease from 2-8 pH. BAV-1 removes a SDS 85-95 %. Due to weak basicity of SDS its acidic form is predominant in acidic solution and much adsorbed by vaividang.

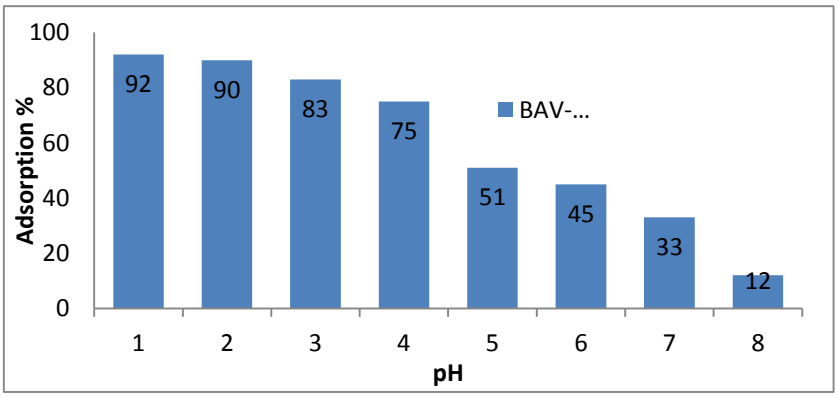

Figure 4 Effect of pH on adsorption of anionic surfactant

Effect of agitation time

To study the effect of time on adsorption efficiency, the same procedure as mentioned above is repeated. The removal efficiency for the 2 mg /L solution was 45 % after 4 hrs. It indicates that adsorption capacity of 2 gm vaividang is 0.45 mg from 2 mg of anionic surfactant. It was found that the % removal of SDS increases with agitation time to the some extent and then remains constant with the increase in agitation time (Figure 5). This is may be due to desorption process.

Effects of bio adsorbent doses:

To investigate our assumption the effect of varying amount of adsorbent on % removal of SDS solution was investigated. A graph was plotted between the different bioadsorbent concentrations with % removal of SDS (Figure 6). The effect of adsorbent dose studies is observed from 1-100gm/L of adsorbent for BAV-1. It was notice that the extant of removal of SDS solution increases with the increase of dose and reached 85-95% when the adsorption dose was ≥75gm /L. The increases in % removal of SDS are due the presence of available more sites for adsorption. When the dose reaches more than 75 gm/L, it is found that % removal of SDS could not increase due to the partial interaction and aggregation.

Effects of adsorbate concentration:

The effect of adsorbate concentration is studied taking a range of 1-100 mg/L of SDS solution with an optimum adsorbent dose and pH value. At lower initial surfactant concentrations, sufficient adsorption sites are available for

the adsorption of SDS. As well as the concentration of SDS increase, there was lacking of the availability of adsorbing sites. Hence, the % of SDS removal correlates inversely with the initial surfactant concentration.

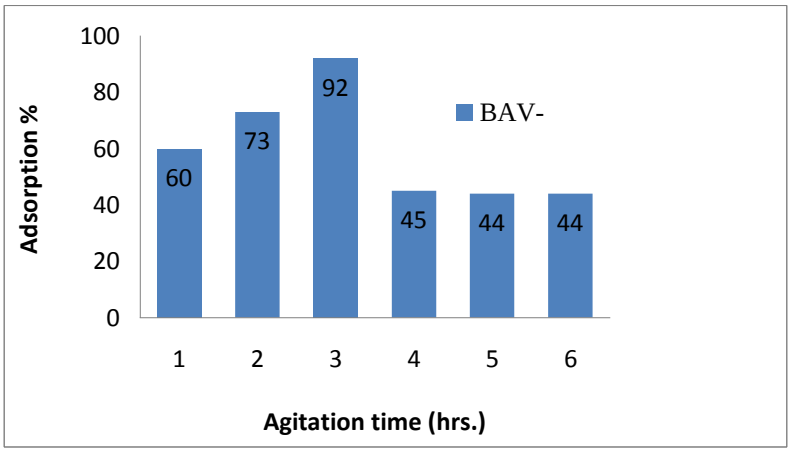

Figure 5 Effect of agitation time on adsorption of anionic surfactant

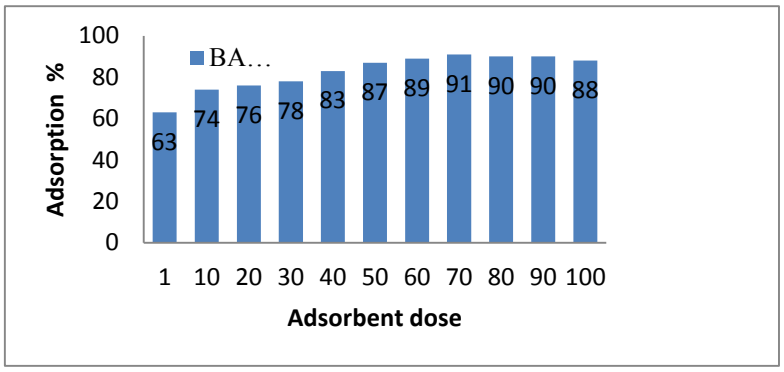

Figure 6 Effect of adsorbent doses on adsorption of anionic surfactant

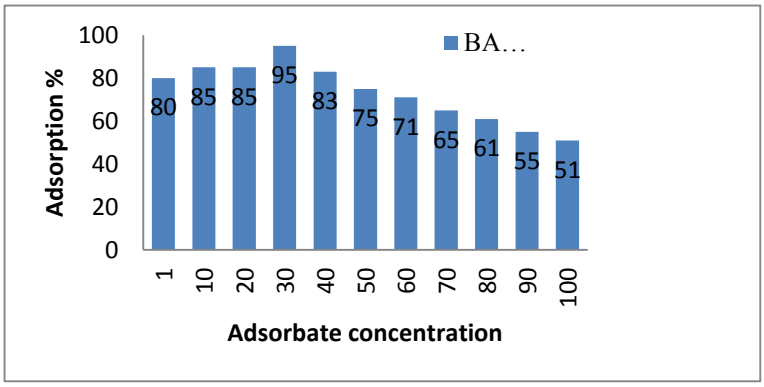

Figure 7 Effect of adsorbate concentration on adsorption of anionic surfactant

Conclusion

In this work the performance of vaividang (Embelia Ribes) for a bio adsorption of anionic surfactant SDS was investigated. The experimental results indicate that absorption on vaividang is an effective way of removing anionic surfactant from wastewater. The results of adsorption depend upon the pH, contact time, doses of adsorbent and concentration of adsorbate. Anionic surfactant SDS revealed their low tendency to be absorbed by vaividang in high pH 6-8. The experiments results also show that the adsorption efficiency is limited when the adsorbate doses and adsorbent concentration is increased due to saturation of vaividang surface. In all cases the sorption is via adsorption, and the longer time also confirms the desorption. The present study showed that vaividang could be effectively used for the adsorption of an anionic surfactant SDS from waste water effluents.

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